From: David Thompson
To: William Althouse
Date: August 4, 2000
Subject: GLAST Balloon Flight Engineering Model - Plan for Balloon Flight

Introduction

The objectives for a balloon flight were described in a separate document. These objectives can be met by a successful flight of a single GLAST tower on a high-altitude scientific balloon. Only a few hours of data with all subsystems operating together can provide a wealth of information about background and atmospheric gamma radiation, enough to demonstrate the ability of GLAST to operate in a high-background space environment.

Achieving a successful balloon flight is not trivial, but it can be managed by drawing extensively on existing hardware, software, and experience. This document outlines the basic approach for detectors, electronics, supporting equipment, and data handling, describes an organization, and proposes a schedule.

Hardware and Data Handling

Detectors

The detector subsystems will largely be upgrades of the ones used for the 1999 beam test - the same ACD scintillators, the same calorimeter CsI, and the same Si strip tracker will be used. Changes needed are largely to handle the potential shock (up to 10 G) when the parachute opens or the payload hits the ground.

Two additional detectors will be added: (1) a set of external scintillator targets, which will provide tags for cosmic ray interactions that may produce gamma rays. These targets represent active "sources" of gamma rays that can be detected against the atmospheric background of gamma rays and cosmic rays. These detectors will be provided by colleagues from Japan. (2) a magnetometer (and possibly an inclinometer if we choose to change elevation during the flight) to measure the azimuth of the payload. Such devices are available from other balloon programs at GSFC or NRL.

Electronics

Significant improvements have been made in the data acquisition electronics that were used for the 1999 beam test. It is these improved electronics that will be used for the balloon flight. In particular, all the tower electronics modules (TEM) and the main processor will be located in one crate, to improve data flow and increase the data throughput rate to that expected for the balloon environment. Some additional modifications will be required in order to handle housekeeping readouts and control of configurations of the detectors, since commanding capability is very limited in a balloon flight.

A new set of electronics, the Balloon Interface Unit (BIU) is required to handle the data and command transfer to and from the transmitter/receiver (which is provided by the

National Scientific Balloon Facility, NSBF). The BIU will be built by NRL, based on an existing system developed for balloon payloads at GSFC. A corresponding command encoder/data decoder will be provided for the equivalent processing on the ground, again based on an existing system.

Supporting Equipment

In order to minimize the potential problems of near-vacuum on the detectors and electronics, the GLAST tower and its electronics will be housed in a 1-atmosphere pressure vessel. Two existing pressure vessels have been identified at Goddard. SLAC will make necessary modifications in the one chosen, in order to support the GLAST equipment.

A thermal analysis will be performed to determine whether any active thermal control is needed for the instrument. If necessary, a simple cooling system can be built.

The pressure vessel containing the GLAST tower will be supported on a gondola built from a nearly-complete spare of a gondola flown many times by the GSFC low-energy gamma-ray group. A decoupling swivel, also provided by the GSFC group, may be used to disconnect the rotation of the balloon from the rotation of the payload. No active control of the azimuth is planned.

Data handling

Timely analysis of both real-time and complete data sets will be important to monitoring and determining the success of the flight. Because the downlink telemetry is limited (probably 128 kbits/s), the plan is to record all data for each Level 1 trigger on-board, while at the same time transmitting some fraction of those data to the ground for monitoring purposes. The telemetered data will also be recorded as a back-up.

Ground Support Equipment (GSE) with real-time displays of housekeeping parameters, rates, and event data will be based on improved versions of the ones used for the 1999 beam test. A complete data processing system, capable of reconstructing tracker events, identifying gamma rays, and computing live time, exposure, and fluxes, will be developed as part of a Mock Data Challenge and will be applied to the balloon data.

Programmatics

A Balloon Flight Working Group was established. This group includes D. Thompson (overall coordination and science management), G. Godfrey (instrument integration and test), and S. Williams (systems engineering and resources management), as well as representative from GLAST subsystems. The group is responsible to W. Althouse, the GLAST LAT Project Manager. Weekly VRVS Conferences of this group started in July.

The organization proposed for implementing the balloon flight is an integrated product team led by D. Thompson, G. Godfrey, and S. Williams. Subsystem refurbishment and integration will be performed within the existing GLAST organizational structure. Within each subsystem, a specific point of contact will be responsible for the balloon flight activity and will report to D. Thompson. The balloon flight management, subsystem points of contact, and some of the staffing are shown below. No single individual with responsibilities for GLAST flight instrument development will be dedicated fulltime to the balloon flight.

Organization

BF Scientist:	*David Thompson*
BF System Engineering:	*Scott Williams*
BF Instrument Integration:	*Gary Godfrey*
BF Flight Software:	*JJ Russell*, Tony Waite, Dan Wood, Dave Lauben
BIU	*Michael Lovellette*, Dan Wood
BF Science Data Processing:	*Richard Dubois*
BF GSE/IOC:	*Scott Williams*, Dave Lauben
BF Electrical Systems:	*Gunther Haller*, *Roger Williamson*, James Wallace, Bob Bumala
BF Active Target	*Tune Kamae*
BF Logistics:	*David Thompson*
BF Tracker	*H. Sadrozinski*
BF Calorimeter	*N. Johnson*
BF ACD	*A. Moiseev*

Schedule

A rough schedule is proposed below. Principal dates include the September design review, January subsystem delivery to SLAC for integration, and June launch date. Preliminary results are intended to be available prior to the Instrument PDR in August 2001.

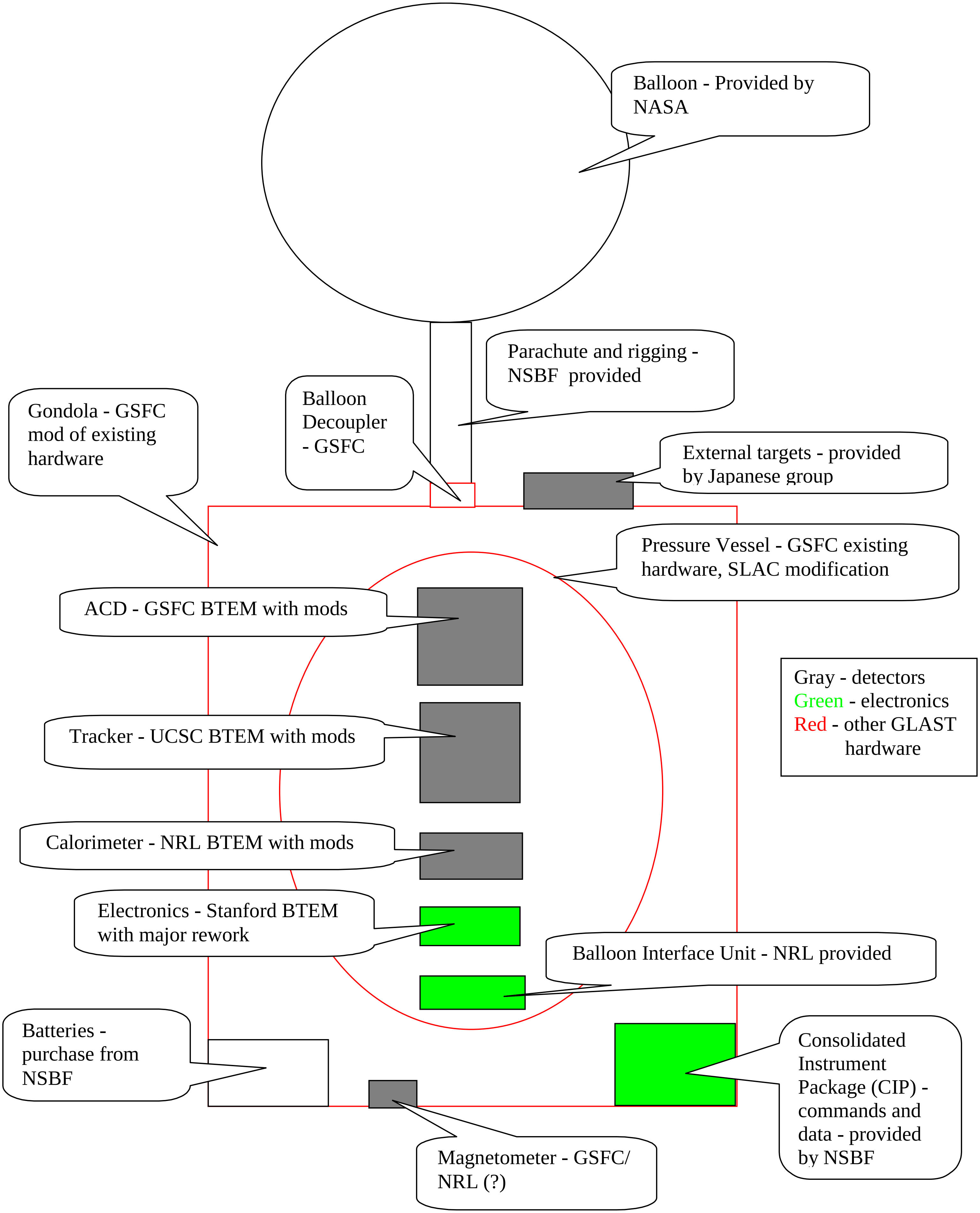
August, 2000	BF requirements review
	BFEM TKR interface and S/W tests at UCSC
	BFEM ACD interface and S/W tests at GSFC
September, 2000	BFEM design review
October-November, 2000	Electrical integration tests at GSFC, NRL and UCSC for ACD, CAL, BIU, TKR, and gondola electronics.
December, 2000	BF pre-integration review
January, 2001	All subsystems ship to SLAC. Receiving and bench tests.
	Gondola assembly at GSFC
February, 2001	Mechanical/Electrical integration including active targets
March, 2001	Software integration
April, 2001	Ship to GSFC, Gondola integration
May, 2001	Ship to Texas
June , 2001	Flight
July , 2001	Data analysis and preliminary performance report

Resources

Manpower for the BFEM development has been largely identified in the Balloon Flight Working Group.

Funding for the necessary mechanical, electrical, and software development, BFEM integration, and balloon flight support was included in the total AO budget of $1,057,000. A detailed WBS and costing exercise is needed to determine whether this funding is adequate for the present plan.

GLAST Balloon Flight Engineering Model (BFEM) - Flight Hardware



GLAST Balloon Flight Top-Level Data and Command Flow